

Research Article

# Mathematical Models for Forecasting Spare Parts Demand in Car Service Enterprises and Comparative Analysis of Results

**Polvonov Abduljalil Sattorovich<sup>1</sup> , Abdusattorov Nodirjon Abduljalil o'g'li<sup>1</sup> ,**  
**Odilov Jakhongir Anvarjon o'g'li<sup>2,\*</sup> , Sulaymonov Dostonbek Salohiddin o'g'li<sup>1</sup> **

<sup>1</sup>Transport Faculty, Namangan State Technical University, Namangan, Uzbekistan

<sup>2</sup>Mechanics and Mechanical Engineering Faculty, Fergana State Technical University, Fergana, Uzbekistan

## Abstract

This study comprehensively examines the challenges of meeting the spare parts demand in car service enterprises. The research addresses key aspects such as maintaining optimal spare parts inventories, organizing efficient storage in warehouses, and improving the processes of ordering, purchasing, and delivering spare parts. To analyze demand patterns, the Poisson distribution is applied, and regression models are used to identify the factors influencing spare parts consumption. The study highlights the importance of developing a multiple regression model to determine the degree of interrelation between these influencing factors. Variables with pair correlation coefficients below the specified significance level are excluded to enhance the model's accuracy and reliability. In addition, the potential of adaptive forecasting models based on the moving average method is explored to predict future spare parts demand effectively. A comparative analysis of the results obtained from different mathematical models demonstrates that the proposed approach provides a more accurate and reliable estimation of spare parts demand for car service enterprises. The findings offer practical guidance for inventory management, helping enterprises maintain sufficient stock levels while minimizing storage costs and operational inefficiencies. By combining statistical modeling with adaptive forecasting techniques, this study provides a comprehensive framework for predicting spare parts demand and supporting decision-making in car service enterprises. The approach contributes to improved operational efficiency, reduced risk of stockouts, and better alignment of inventory with actual service requirements.

## Keywords

Car Service, Spare Parts Management, Regression Models, Poisson Distribution, Probability and Statistical Analysis, Maintenance and Repair Processes

## 1. Introduction

One of the indicators of a high-quality car service is the proper organization of its production-technical base. In this regard, many tasks of material and technical supply are dis-

tinguished, the most important of which are: maintaining optimal stocks of spare parts, ensuring their constant availability in warehouses, and optimizing the processes of ordering,

\*Corresponding author: [ojaxonngir89@gmail.com](mailto:ojaxonngir89@gmail.com) (Odilov Jakhongir Anvarjon o'g'li)

**Received:** 3 October 2025; **Accepted:** 14 October 2025; **Published:** 28 October 2025



Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

purchasing, and delivering spare parts.

If the tasks assigned to material and technical supply are performed unsatisfactorily:

- 1) it disrupts the operation of the production-technical base of car service enterprises, and at the same time, the need arises for increasingly more storage spaces for cars waiting for technical service and repair;
- 2) the downtime of cars during technical service and repair increases;
- 3) queues for technical service increase;
- 4) the flow of forced refusals of technical service due to the shortage of spare parts increases;
- 5) the level of competitiveness of the car service in internal and external markets decreases;
- 6) the popularity of certain car brands decreases.

Solving the above-mentioned problems makes it possible to create a scientifically-based system for managing spare parts stocks in car service enterprises.

## 2. Manuscript Formatting

The system of supplying spare parts to automobile technical service enterprises is a mass service system corresponding to the main characteristics of such systems. The demand for spare parts used for automobile technical service and repair generates a random flow of requests, and the demand for spare parts is characterized by the Poisson distribution [1, 2, 5].

$$P_{ka} = \frac{a^k}{k!} e^{-a}, \quad (1)$$

Here,  $P_{ka}$  denotes the probability that the number of required spare parts is equal to  $k$ , given that the average number of spare parts consumed during the entire considered time interval is  $a$ .

In car service enterprises, which include the enterprises themselves, their departments, and the range of services provided, the flow of spare parts demand is divided into small groups depending on the specialization of the enterprise and the volume of spare parts consumed by its departments. Modern dealership enterprises, in addition to their service base, also have a department engaged in wholesale and retail trade of spare parts. The sales department deals with the sale of spare parts. In addition to these departments, the enterprise also operates its own motor fleet for production and economic needs, departments for the sale of new and used cars, and in some enterprises, there is also a car rental service.

The total consumption of spare parts in a car service enterprise within a modern dealership network can be expressed by the following formula [2, 4, 5, 7]:

$$Q = Q_{eht} + Q_{sot} + Q_{saroy} + Q_{ij} + Q_{avs} \quad (2)$$

Here,  $Q_{eht}$  is the demand for spare parts for technical ser-

vice and repair;  $Q_{sot}$  is the demand for spare parts of the sales department;  $Q_{saroy}$  is the demand for spare parts of the motor fleet;  $Q_{ij}$  is the demand for spare parts of the car rental department;  $Q_{avs}$  is the demand for spare parts of the car sales department [7, 8].

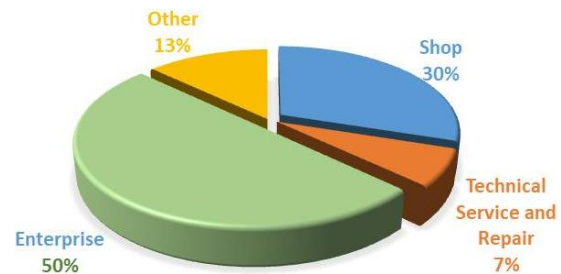
The spare parts sales department may consist of several divisions, including retail, wholesale, and order divisions. In addition, the enterprise may also have a technical emergency service department that uses spare parts.

To determine the consumption of spare parts in an enterprise, the consumption of spare parts through the auxiliary services of technical service and repair can be combined into a single general component, since the above-mentioned services are provided to car service enterprises by the technical service, except for the expenses corresponding to the spare parts sales department. Thus, for such an enterprise, the demand for spare parts ( $Q$ ) can be expressed by the following formula:

$$Q = Q_{AS} + Q_{dork} \quad (3)$$

Here,  $Q_{AS}$  is the total demand for spare parts of the car service, and  $Q_{dork}$  is the demand for spare parts of the auto shop.

Figure 1 shows the approximate distribution of spare parts consumption among the main consumer departments of the "AVTOTEXXIZMAT-F" JSC car service enterprise located in Margilan city, based on the results of 2024.



**Figure 1.** Distribution of spare parts consumption among the departments of the enterprise.

When calculating the total demand for spare parts of a car service enterprise ( $Q_{AS}$ ), reliable information on operational factors and the composition of the motor fleet is required; in contrast, when calculating such demand for the auto shop ( $Q_{dork}$ ), obtaining information on operational factors and fleet composition becomes significantly more complicated [7, 8].

Considering that for large values of  $k$ , the Poisson distribution can be approximated by the normal distribution, we use this law to determine  $Q_{dork}$ .

According to the normal distribution law, the probability that  $Q_{dork}$  is less than  $Q + z\sigma$  is as follows:

$$P(-\infty < Q_{do'k} < Q + z\sigma) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-\frac{t^2}{2}} dt \quad (4)$$

Here,  $Q$  is the mathematical expectation of the distribution;  $z$  is the normalized deviation from the mean;  $\sigma$  is the standard deviation. Given the probability  $P$ , we determine the value of  $z$  that satisfies the following condition [9, 10]:

$$\frac{1}{\sqrt{2\pi}} \int_0^z e^{-\frac{t^2}{2}} dt = P \quad (5)$$

The required quantity of spare parts with the necessary designation:

$$Q_{do'k} = Q + z\sigma \quad (6)$$

Here,  $Q$  and  $\sigma$  are, respectively, the mathematical expectation and the standard deviation.

If during the experiments the consumption of spare parts does not follow the above laws, it is not appropriate to use this forecasting model.

This allows for determining the patterns of such consumption and selecting the mathematical framework that ensures the highest accuracy in forecasting the demand for spare parts.

## 2.1. Use of Regression Models

When performing practical calculations to forecast changes in the parameters of various systems, regression models are often used if information about the factors affecting these parameters is available. To take into account the influence of the specified factors on spare parts consumption and to determine the degree of interrelation between the factors, it is necessary to develop a multiple regression model.

In this case, the result of spare parts consumption is denoted by  $Y$ , while the remaining variables  $x_1 \dots x_m$  represent the factor variables [13, 14].

In general, the regression equation for forecasting the demand for spare parts can be expressed as follows:

$$Y = a_0 + a_1x_1 + a_2x_2 + \dots + a_mx_m \quad (7)$$

Here,  $x_{1\dots m}$  are the factor variables.

Only those factors that can be quantitatively measured and whose changes can be forecasted under the conditions of a car service enterprise are included in the model.

To construct a multiple regression model for the dependent variable, it is first necessary to select the factor variables for the model. For this purpose, the pairwise correlation coefficients ( $r_{yx1}, r_{yx2}, r_{x1x2}$ ) are calculated. For example:

$$r_{yx1} = \frac{\overline{yx_1} - \overline{y}\overline{x_1}}{\sigma_y \sigma_{x1}} \quad (8)$$

Here,  $\sigma_y$  and  $\sigma_{x1}$  are the standard errors of the corresponding samples.

$$\sigma_y = \sqrt{\frac{\sum(y-\bar{y})^2}{n}}; \quad \sigma_x = \sqrt{\frac{\sum(x-\bar{x})^2}{n}} \quad (9)$$

Factors whose pairwise correlation coefficients with the dependent variable are below the specified significance level are not included in the model. In practice, when calculating the demand for spare parts, the given significance level is assumed to be 0, 5.

At the next stage, the presence of multicollinear factor variables is checked. From each such pair of variables, only one is selected for the model, namely the variable with the highest  $r_{yxn}$  coefficient [5]. When selecting factors for the spare parts demand forecasting model, a pairwise correlation coefficient greater than 0.8 between factors is considered an indicator of multicollinearity.

The model parameters  $a_0, a_1, \dots, a_m$  of the regression equation are estimated using the least squares method, which can be expressed in matrix form. The following notations are adopted:

$\alpha = (\alpha_j), j = 0, 1, \dots, m$  - vector of unknown parameters;  
 $m$  - number of unknown parameters;  $a = (a_j)$  - vector of estimated parameters;  $y = (y_i), i = 1, \dots, n$  - vector of values of the dependent variable;  $n$  - number of observations;  $X = (x_{ij})$  - matrix of values of independent variables of size  $n(m+1)$ ;  $\varepsilon = (\varepsilon_i)$  - vector of errors in the model;  $e = (e_i)$  - vector of residuals in the equation. In standard notation, the vector is understood as a column vector, i.e., as a matrix of size  $n \times 1$  [7, 11, 12].

The regression equation with estimated parameters can be expressed in the following form:

$$\hat{y} = X \cdot a.$$

General form of the model in vector notation:

$$\hat{y} = X \cdot a + e. \quad (10)$$

The sum of squared deviations is equal to:

$$Q = \sum e_i^2 = e^T \cdot e \quad (11)$$

Differentiating  $Q$  with respect to  $a$ , we obtain:

$$\frac{\partial Q}{\partial a} = -2X^T \cdot y + 2(X^T \cdot X)a \quad (12)$$

By setting the derivative equal to zero, we obtain the following expression to determine the vector of estimated parameters  $a$ :

$$\begin{aligned} X^T \cdot y &= X^T \cdot X \cdot a, \\ a &= (X^T \cdot X)^{-1} \cdot (X^T \cdot y). \end{aligned} \quad (13)$$

Differentiating  $Q$  with respect to  $a$ , we obtain the following [3]:

$$\frac{\partial Q}{\partial a} = -2X^T \cdot y + 2(X^T \cdot X)a \quad (14)$$

By setting the derivative equal to zero, we obtain the following expression to determine the vector of estimated parameters  $a$  [2]:

$$\begin{aligned} X^T \cdot y &= X^T \cdot x \cdot a, \\ a &= (X^T \cdot x)^{-1} \cdot (X^T \cdot y) \end{aligned} \quad (15)$$

Calculating the parameters of a regression equation is a time-consuming process. Currently, practical computer software packages can perform this automatically.

After calculating the partial correlation coefficients, we determine the multiple correlation coefficient  $r_y$ , which expresses the degree of relationship between the dependent and factor variables. In general, this coefficient is calculated using the following formula [6]:

$$r_y = \sqrt{\frac{\sigma_{y12...m}^2}{\sigma_y^2}} = \sqrt{1 - \frac{\sigma_{y(12...m)}^2}{\sigma_y^2}} \quad (16)$$

Here,  $\sigma_{y12...m}^2$  is the variance of the factors.

$\sigma_{y(12...m)}^2$  - residual variance;  $\sigma_y^2$  - variance of the dependent variable.

$$\begin{aligned} \sigma_{y12...m}^2 &= \frac{\sum_1^n (\hat{y}_i - \bar{y})^2}{n-1}; & \sigma_{y(12...m)}^2 &= \frac{\sum_1^n (y_i - \hat{y}_i)^2}{n-1} \\ \sigma_y^2 &= \frac{\sum_1^n (y_i - \bar{y})^2}{n-1} \end{aligned} \quad (17)$$

Here,  $\hat{y}_i$  is the calculated value of the dependent variable;  $y_i$  is the mean value of the dependent variable.

The accepted form of the indices means the following:  $\sigma_{y12...m}^2$  - variance of  $\hat{y}_i$  taking into account the factors  $x_1 \dots x_m$ ;  $\sigma_{y(12...m)}^2$  - variance of  $\hat{y}_i$  with the influence of factors  $x_1 \dots x_m$  removed.

The closer the actual values of  $y_i$  are to the regression line, the smaller the residual variance, i.e., the greater the variance explained by the factors, and, consequently, the larger the value of  $r_y$ .

Thus, the multiple correlation coefficient, like the magnitude of the residual variance, characterizes the quality of the regression equation fit [5].

To assess the quality of a regression model, it is necessary to evaluate the significance of the multiple correlation coefficient. This evaluation is carried out using the Student's t-statistic by testing the null hypothesis that the k-regression coefficient is equal to zero ( $k = 1, 2, \dots, m$ ). The calculated value of the t-statistic, with degrees of freedom ( $n - m - 1$ ), is determined by dividing the k-th regression coefficient by its standard error  $\sigma_{ry}$  [1, 6, 7].

$$\sigma_{ry} = \frac{\sqrt{1-r^2}}{\sqrt{n-m-1}}; \quad t_{rs} = \frac{r_y}{\sigma_{ry}} = r_y \cdot \sqrt{\frac{n-m-1}{1-r^2}}. \quad (18)$$

The calculated value  $t_{rs}$  is compared with the critical value  $t_k$ . The  $t_k$  value is taken from the Student's t-distribution table, considering the given significance level and the number of degrees of freedom  $k$ . If the calculated value of  $t_{rs}$  exceeds the critical value, the correlation coefficient is considered significant, and the relationship between the dependent variable and the set of factor variables is strong.

Next, the multiple regression model is analyzed. The significance of this model is evaluated using Fisher's F-statistic. In this case, the null hypothesis assumes that all regression coefficients are equal to zero, i.e.,  $a_i = a_1 = \dots = a_m = 0$  - the model is considered insignificant. The alternative hypothesis assumes that at least one  $a_i$  is not equal to zero [5].

The actual value of Fisher's F-statistic is determined using the following formula:

$$F_{rs} = \frac{r_y^2}{1-r_y^2} \cdot \frac{n-m-1}{m} \quad (19)$$

Here,  $m$  is the number of parameters in the regression equation.

The value of  $F_{rs}$  is compared with  $F_{ad}$ , which is determined from the F-table for the given significance level and degrees of freedom  $k_1 = n-1$  and  $k_2 = n-m-1$ .

If the calculated value of the criterion exceeds the critical value, the alternative hypothesis is considered valid, i.e., the multiple regression model is significant.

In practice, not all software can perform a detailed analysis of the constructed regression model. When using standard practical software packages to calculate the demand for spare parts, it is advisable to use packages that assess the quality and significance of the regression model.

To evaluate the proportion of variation in the dependent variable explained by the factor variables, the coefficient of determination  $D=r_y^2$  is used.

Regression coefficients can only be directly compared if they are expressed in the same units. Most of the factors affecting the demand for spare parts have different units of measurement (kilometers, pieces, days, etc.).

To make the regression coefficients comparable, standardized regression coefficients  $\beta_j$  should be used. The  $\beta_j$  coefficient indicates the amount of change in the standard error of the dependent variable when the factor  $x_j$  changes by one standard error:

$$\beta_j = a_j \cdot \left( \frac{\sigma_{x_j}}{\sigma_y} \right) \quad (20)$$

Here,  $a_j$  is the regression coefficient for the factor  $x_j$ ;  $\sigma_{x_j}$  and  $\sigma_y$  are the standard errors of the factor and the dependent variable, respectively.

Elasticity coefficients are calculated to estimate how many

percent the dependent variable changes when the value of a factor variable changes by 1%. Using a multiple regression econometric model, to know the forecasted values of all factors included in the model, it is necessary to perform an *l*-step-ahead forecast of the demand for spare parts. These values can be obtained using extrapolation methods based on the average absolute increase of the factor variables. The forecasted values of the factors can be set by the specialist responsible for organizing spare parts supply or obtained through expert assessments. The forecasted factor values are input into the model, and point forecasts for the demand for spare parts in the required nomenclature are obtained.

If subsequent studies indicate that applying a linear multiple model is not appropriate, the dependence of spare parts demand on factor variables is described by nonlinear equations. In such cases, to estimate the regression parameters, the regression equation needs to be converted into a linear form, which can be done by logarithmic transformation. The drawback of logarithmic transformation is that the estimates of regression parameters are obtained in a shifted form.

In general, the estimation of parameters of a nonlinear regression is carried out using the nonlinear least squares method. For this, the sum of squared deviations between the calculated values  $f(a_1, a_2, \dots)$  and the actual values  $y_j$  of the dependent variable is minimized, and  $Q$  is determined by

differentiating with respect to the parameters  $a_j$ .

$$Q = \sum e_t^2 = \sum [y_t - f(a_1, a_2, \dots)]^2 \quad (21)$$

As a result, a system of normal equations is obtained. The system is linearized using the Taylor series, and then the linear least squares method is applied.

As a result, a system of normal equations is obtained. The system is transformed into a linear form using the Taylor series, and then the linear least squares method is applied.

## 2.2. Comparison of the Results of Calculating the Demand for Spare Parts Using Mathematical Models

The presented methods are convenient for performing practical calculations using a personal computer. To implement them, data on spare parts consumption for at least the previous 12 months of the enterprise is required.

Using the constructed model and the Regrel.O program, we calculate the demand for steering racks. In this case, we use the forecasted values of the factor variables for January 2024 (Table 1).

**Table 1.** Forecasted values of the factor variables.

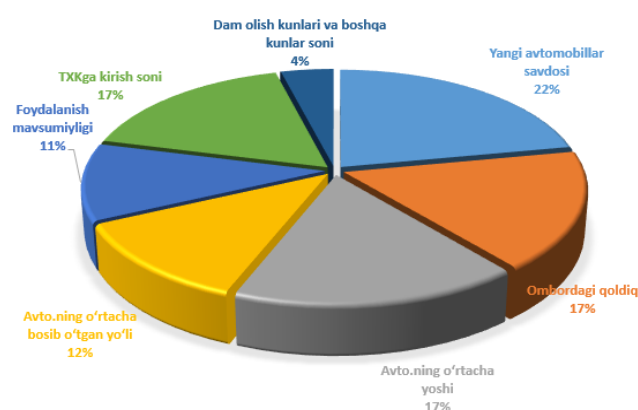
| Month | Distance | Number of Entries | Vehicle Age | Usage Seasonality | Stock in Warehouse | New Vehicle Production | Number of Outputs and Days |
|-------|----------|-------------------|-------------|-------------------|--------------------|------------------------|----------------------------|
| 1     | 65       | 90                | 5           | -10               | 45                 | 120                    | 13                         |

After entering the data, we obtain the following result:  $Y=22.71$ .

The diagram showing the influence of the factor variables on the dependent variable, generated by the program, is presented in Figure 2.

These methodologies (using a personal computer) are convenient for performing practical exercises. To implement them, information on the enterprise's spare parts expenditures for previous months is required (at least 12 months).

To obtain the forecast of demand for steering racks using the STADIA 6.3 program, we use the nonlinear forecasting model obtained above. The forecasted values of the factor variables for January 2024 are entered into the program (see Table 1). After entering the data, we obtain the following result for the nonlinear model:  $Y=22.71$ .



**Figure 2.** Degree of influence of the main factors on steering rack consumption.

Since there is no forecast of changes in the dependent in-



dicators for the entire period of 2024 at the “AVTO-TEXXIZMAT-F” JSC car service enterprise in Margilan, it is difficult to obtain forecasted values of spare parts demand for the whole year.

For January 2024, we compare the demand values for steering racks obtained using Regre 1.0 (22.71) and STADIA 6.3 (23.30). Although the STADIA program takes into account the influence of the entire set of factors, the difference between the forecasts is relatively small. The actual consumption of the studied spare part was 20 units; however, this does not indicate the accuracy of either method, as analyzing spare parts consumption over at least one year is required. Nevertheless, the method of selecting factors for the model allows saving time for later collection of data on factors that do not significantly affect the result.

The results of the nonlinear regression model analysis ( $Y=22.71$ ) are very close to the linear model, but when using the nonlinear model, forecasting errors can even be higher. The nonlinear model is built based on the selection of empirical formulas, and additional data analysis is required when choosing empirical formulas. Therefore, using a linear model

for forecasting spare parts demand is advisable.

Using the adaptive forecasting model created based on the moving average (smoothing small delays), the forecasted demand for spare parts was 22.0, which differs significantly from the values obtained using regression models. This is explained by the nonlinear change in spare parts consumption throughout the year. Applying this adaptive model is appropriate when analyzing the consumption of spare parts belonging to Group 3 (engine). In this group, there is a consistent trend in consumption changes without sharp jumps in increasing or decreasing directions.

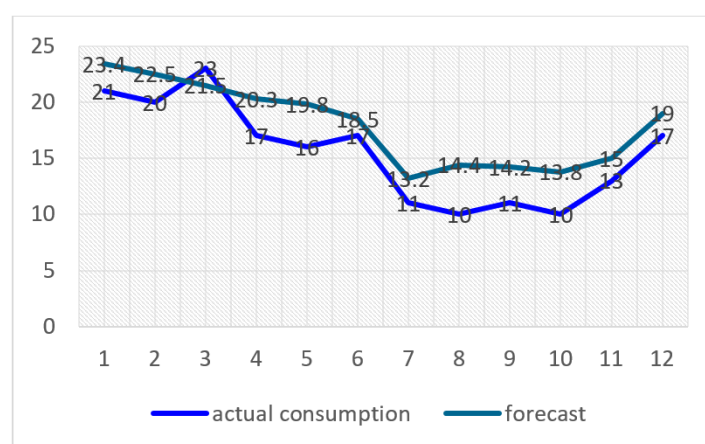
To justify the choice of a forecasting model based on the character of the spare parts consumption curve, we calculate the demand for spare parts for 2024 using the example of GTM belts and injectors, and then compare the obtained values with the actual consumption of these parts.

For calculating the demand for GTM belts, we use the adaptive forecasting model, while for the demand for front bumpers, we use a model based on Fourier series harmonics.

The practical and calculated quantities of spare parts demand are shown in Table 2.

**Table 2.** Practical and calculated demand for timing mechanism (GTM) belts (25195582) and injectors (25181804) in 2024.

| Assemblies /Months              | 1    | 2    | 3    | 4    | 5    |      |
|---------------------------------|------|------|------|------|------|------|
| Actual Consumption of GTM Belts | 21   | 20   | 23   | 17   | 16   |      |
| Forecasted Demand for GTM Belts | 23,4 | 22,5 | 21,5 | 20,3 | 19,8 |      |
| Actual Consumption of Injectors | 21   | 16   | 17   | 19   | 15   |      |
| Forecasted Demand for Injectors | 19,2 | 17,9 | 18,2 | 20,1 | 20,8 |      |
| Assemblies /Months              | 6    | 7    | 8    | 9    | 10   | 11   |
| Actual Consumption of GTM Belts | 17   | 11   | 10   | 11   | 10   | 13   |
| Forecasted Demand for GTM Belts | 18,5 | 13,2 | 14,4 | 14,2 | 13,8 | 15,0 |
| Actual Consumption of Injectors | 13   | 12   | 10   | 10   | 14   | 16   |
| Forecasted Demand for Injectors | 12,6 | 10,7 | 12,4 | 11,7 | 15,3 | 18,7 |



**Figure 3.** Actual consumption and forecast of GTM belts (catalog number 25195582).

Figure 3 shows the forecasted demand for spare parts and the actual consumption curve of GTM belts at the enterprise in 2024.

### 3. Results

The graph shows that the change in GTM belt consumption has a smooth character without sharp fluctuations.

Figure 4 presents the forecasted demand for spare parts and the actual consumption curve of the front bumper in 2024.

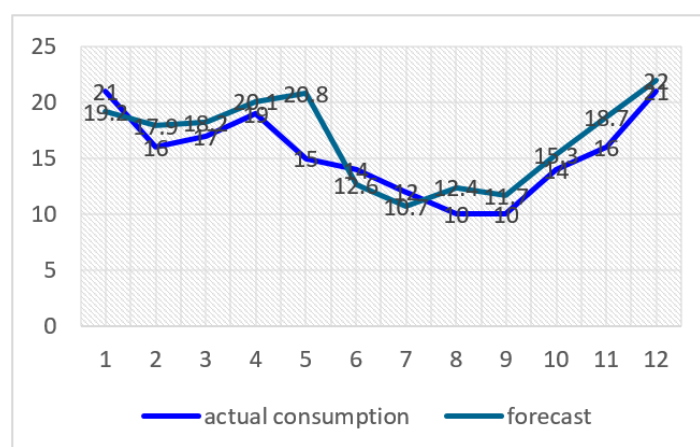


Figure 4. Actual consumption and demand forecast of injectors (catalog number 25181804).

$$\varepsilon_{nis} = \frac{1}{n} \cdot \sum \left| \frac{y_t - \hat{y}_t}{y_t} \right| \cdot 100\%, \quad (22)$$

Here  $y_t$  and  $\hat{y}_t$  are the actual and estimated values of the time series, respectively.

### 4. Conclusions

This study addressed the problem of correlation-regression analysis in evaluating software tools for statistical and operational research. The analysis showed that Regre 1.0 software most fully meets the stated requirements for such analyses. However, for a more comprehensive and detailed study, it is recommended to use additional software packages, such as STADIA 6.3 [1]. Future research could explore the integration of these tools with other statistical and machine learning methods to further enhance the accuracy and efficiency of correlation-regression analyses.

### Abbreviations

|                               |                                       |
|-------------------------------|---------------------------------------|
| $a_j$                         | Regression Coefficient for the Factor |
| $\sigma_{x_j}$ and $\sigma_y$ | Standard Errors of the Factor         |

The figure also illustrates the spare parts consumption curve, which served as the basis for constructing the forecasting model.

The forecasting models for GTM belts and front bumpers are adequate, and in both models the number of peak points is equal to 6.

To evaluate the accuracy of the applied models, we calculate the mean relative approximation error for each of them:

|                       |                                                              |
|-----------------------|--------------------------------------------------------------|
| $y_t$ and $\hat{y}_t$ | Actual and Estimated Values of the Time Series, Respectively |
| $\hat{y}_i$           | Calculated Value of the Dependent Variable                   |

### Author Contributions

**Polvonov Abdujalil Sattorovich:** Conceptualization, Data curation, Methodology, Resources, Software, Supervision, Visualization, Writing – review & editing

**Abdusattorov Nodirjon Abdujalil o'g'li:** Conceptualization, Formal Analysis, Methodology, Resources, Supervision, Visualization, Writing – review & editing

**Odilov Jakhongir Anvarjon o'g'li:** Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

**Sulaymonov Dostonbek Salohiddin o'g'li:** Conceptualization, Data curation, Formal Analysis, Methodology, Project administration, Supervision, Validation, Visualization

### Conflicts of Interest

The authors declare no conflicts of interest.

## References

- [1] Economic-Mathematical Methods and Applied Models: A Textbook for Universities / Edited by V. V. Fedoseev. - Moscow: UNITY, 2002. - 391 p.
- [2] General Theory of Statistics: Statistical Methodology in the Study of Commercial Activity: Textbook / Edited by O. E. Bashina, A. A. Spirin. - 5th ed., revised and supplemented. - Moscow: Finance and Statistics, 2003. - 440 p.
- [3] Musajonov M. Z. Fundamentals of Designing Auto Service Enterprises. - Tashkent: "Tamaddun" Publishing House, 2017.
- [4] Polvonov A. S. Fundamentals of Designing Auto Service Enterprises: Textbook for Higher Education Institutions. - Namangan: "Usmon Nosir Media", 2023. - 283 p.
- [5] Grishin A. S. Development of a Methodology for Forecasting the Demand of Auto Service Enterprises for Spare Parts: Dissertation for the Degree of Candidate of Technical Sciences: 05.22.10 - Moscow, 2005.
- [6] Bugrimov V. A. Modeling the Flow of Spare Parts Orders in Auto Service / V. A. Bugrimov, A. V. Kondratyev, V. I. Sarbaev // Efficiency of Technical Operation and Auto Service of Transport and Technological Machines, 3rd International Scientific Conference of Students and Young Scientists. - Saratov, 2017. - P. 14-19.
- [7] Polvonov A. S., Odilov J. A. Avtoservis korxonalarida ehtiyot qismlarga bo'lgan talab darajasini o'rganish. Spectrum Journal of Innovation, Reforms and Development. Veb-sayt: [www.sjird.journalspark.org](http://www.sjird.journalspark.org)
- [8] A. S. Polvonov, D. S. Shotmonov, N. A. Abdusattorov, J. A. Odilov, D. S. Sulaymonov. Matematik modellardan foydalanib ehtiyot qismlarga bo'lgan talabni hisoblash natijalarini taqqoslash. "Iqtisodiyot va Jamiyat" №7(134), 2025. Veb-sayt: [www.iupr.ru](http://www.iupr.ru)
- [9] Polvonov A. S. Avtoservis korxonalarida ehtiyot qismlarning aylanma fondi hajmini optimallashtirish masalasini hal qilish. Ilmiy jurnal "Mexanika va Texnologiya". Namangan, 2024, №3, maxsus son. B. 80-85.
- [10] Polvonov A. S., Abdusattorov N., Soataliev D. Avtoservis korxonalarini joylashtirish masalasini simulyatsion model dasturi asosida amalga oshirish. Namangan Davlat Qurilish va Injenerlik Instituti, "Mexanika va Texnologiya" ilmiy jurnali, №1 (10), 2023.
- [11] Sharipov K., Polvonov A., Abdusattorov N., Theoretical aspects of territorial location modeling of automobile service enterprises. The Seybold REPORT ISSN 1533-9211 <https://doi.org/10.5281/zenodo.6969377> V 17. I 08. 2022.
- [12] Polvonov, I. Mukhamadov, D. Soataliyev. Study of the Ultimate Stress, Relative Elongation, and Specific Work at the Rupture of Vilad-11 Polyurethane Adhesive. Namangan State University of Engineering, Journal of Mechanics and Technology, No. 1 (6), 2022.
- [13] Burger, N., Laachachi, A., Ferriol, M., Lutz, M., Toniazio, V., Ruch, D. Review of thermal conductivity in composites: Mechanisms, parameters and theory. Prog. Polym. Sci. 2016-обзор механизмов теплопроводности композитов.
- [14] Wang, J. et al. Development and Perspectives of Thermally Conductive Polymer Composites. MDPI (2022) — Analysis of the Current State and Prospective Directions in the Creation of Polymer Composites with High Thermal Conductivity. MDPI.

## Biography



**Polvonov Abduljalil Sattorovich** is a Candidate of Technical Sciences and Professor at the Department of Transport Engineering at Namangan State Technical University. Since May 1, 2023, he has held the position of Professor in this department. He was born on December 15, 1955, in Kosonsoy District, Namangan Region. He holds a higher education degree, having graduated in 1983 from the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (full-time program). His academic specialization is agricultural mechanization. He holds the academic degree of Candidate of Technical Sciences and the academic title of Professor.



**Abdusattorov Nodirjon Abduljalil o'g'li** - PhD in Technical Sciences, Head of the Department of Road Traffic Safety at Namangan State Technical University. He is the author of more than 30 scientific and methodological works, including over 40 articles and conference abstracts. He has 5 years of professional experience, including 4 years in academic and pedagogical activities. His research interests include the operation and restoration of transport vehicles, as well as issues related to road traffic safety.



**Odilov Jakhongir Anvarjon o'g'li** is currently a PhD student at Fergana State Technical University. He is conducting scientific research in the field of mechanics and mechanical engineering. To date, he has published more than 10 scientific articles in international and national journals related to his field of study.





**Sulaymonov Dostonbek Salohiddin o'g'li** is a lecturer at the Department of Transport Engineering of Namangan State University of Technology. His scientific work focuses on transport systems and their engineering, and he is the author of numerous research papers and studies in these areas. His contribution to science and efforts in educating the younger generation have established him as one of the leading specialists in his field.

## Research Field

**Polvonov Abduljalil Sattorovich:** Agricultural Mechanization, Transport Engineering, Irrigation and Agricultural Machinery, Design and Operation of Technological Machines, Mechanical Systems Reliability, and Efficiency of Machine Components.

**Abdusattorov Nodirjon Abduljalil o'g'li:** Transport Engineering, Irrigation and Agricultural Machinery, Design and Operation of Technological Machines, Efficiency of Machine Components, Mechanical Systems Reliability.

**Odilov Jakhongir Anvarjon o'g'li:** Agricultural Machinery Design, Irrigation Equipment Optimization, Transport and Agricultural Engineering, Technological Machine Dynamics, Mechanical Reliability of Machinery, Efficiency and Energy Conservation in Agricultural Systems.

**Sulaymonov Dostonbek Salohiddin o'g'li:** Agricultural Mechanization, Transport Engineering, Irrigation and Agricultural Machinery, Design and Operation of Technological Machines, Mechanical Systems Reliability, and Efficiency of Machine Components.